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Signed Stephen Hordley

Dated 6 August 2004

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Request for grant of a patent

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1.	Your reference	A30385
		21JUL03 E823771-1 C01590 P01/7700 0.00-0316891.1
2.	Patent application number *(The Patent Office will fill in this part)*	0316891.1
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	BRITISH TELECOMMUNICATIONS public limited company 81 NEWGATE STREET LONDON, EC1A 7AJ, England Registered in England: 1800000
	Patents ADP number *(if you know it)*	1867002
	If the applicant is a corporate body, give the country/state of its incorporation	UNITED KINGDOM
4.	Title of the invention	TEST DEVICE FOR DATA SERVICES
5.	Name of your agent *(if you have one)*	
	"Address for Service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	BT GROUP LEGAL INTELLECTUAL PROPERTY DEPARTMENT HOLBORN CENTRE 120 HOLBORN LONDON, EC1N 2TE
	Patents ADP number *(if you know it)*	1867001 08591919001
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country / Priority application number *(if you know it)* / Date of filing *(day / month / year)*
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8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *(See note (d))*	YES

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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*

Request for preliminary examination and search *(Patents Form 9/77)*

Request for substantive examination *(Patents Form 10/77)*

Any other documents *(please specify)*

11. I/We request the grant of a patent on the basis of this application.

Signature(s)

WALLIN, Nicholas James, Authorised Signatory

Date: **18 July 2003**

12. Name and daytime telephone number of person to contact in the United Kingdom **Rod HILLEN** **020 7492 8140**

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DUPLICATE

Test Device for Data Services

The present invention relates to test devices for data carrying services operating over a telecommunications metallic pair. More particularly, but not exclusively, to a device which is able, via a single port, to automatically identify and confirm the correct operation of one of a number of data services, including ISDN (bri) (Integrated Services Digital Network Basic Rate Interface), ADSL (Asymmetric Digital Subscriber Line), ShDSL (Single pair High bit rate Digital Subscriber Line) and POTS (Plain Old Telephony Service).

In the communications field, an ever increasing range of technologies means that there are increasing requirements for apparatus which is able to test and monitor the provision of different data carrying services (ISDN, ADSL, etc) which may run over telecommunications lines. A multitude of products are available on the market including a number of hand held devices with which a user is able able to test the operation of individual services.

Prior art apparatus include, for example the Aurora Tango from Trend Communications Ltd (http://www.trendcomms.com). This is modular apparatus, which allows testing of a plurality of different services including ShDSL, ADSL and ISDN. The apparatus comprising a plurality of detachable modules, each for testing one of the services. The modules may be swapped as appropriate to test for a different service, thereby offering a flexible testing apparatus. However, although this arrangement offers a highly flexible solution, it also requires a high level of understanding and operator skill. In order for the device to function correctly, it is critical that the correct port of the tester is connected to the correct type of service.

In addition it is advantageous to be able to simulate an extended length of copper pair when testing a service. For example, this can be used to confirm when testing the central office that the DSLAM card is capable of communication over a standard line length rather than the actual line length which is present. By simulating a longer length of wire in this way and thereby putting the DSLAM card under stress it is possible to identify additional problems not usually identified, as the circuit would normally appear to conform to the standard of service.

Known methods for simulating different lengths of cable involve the connection of additional pieces of equipment. Typically, an engineer will connect a cable drum (i.e. rolled length of actual cable) to the relevant part of the line, to thereby put the circuit under load. However, from a safety point of view this is not an optimum procedure because excessive lengths of cable must be carried around. In addition, such testing procedures produce non-standard results because the different cable lengths used by different engineers will produce different losses.

The present invention seeks to provide an improved test apparatus for testing data carrying services operating over telecommunications line (by line here is meant a single twisted metallic pair, although in the case of ISDN S-bus the service is over two metallic pairs).

According to a first aspect of the present invention, there is provided a device for identifying and testing data carrying services operating over a telecommunications line, the apparatus comprising:

an input port for connection to the line so as to receive service data;

a processing unit; and

test circuit means capable of identifying and testing in co-operation with the processing unit a plurality of different data carrying services using the data received via said input port.

This device is therefore able to identify and test a plurality of different data carrying services via only a single connection port. Advantageously, an automatic test procedure can be performed by the device, which will be connected in a consistent way to the line irrespective of which service is being carried over the line. Since there is no requirement to connect to different ports for different services, the device can be operated by a less-skilled engineer than would otherwise be required. They do not require information in advance as to which service type to test for, and a time saving can be made since it is not necessary to disconnect and reconnect a large number of different devices. The services which can be tested for may include, for example, any combination from Asymmetric Digital Subscriber Lines (ADSL), Integrated Services Digital Network Basic Rate Interface (ISDN bri), Single pair High bit rate Digital Subscriber Lines (ShDSL) and POTS (Plain Old Telephony Service).

According to a second aspect of the present invention, there is provided a device for testing a data carrying service operating over a telecommunications line between a first and second terminal, the apparatus comprising:

a first port for connecting to the first terminal on the line so as to send and receive service data to and from the first terminal;

a second port for connecting to the second terminal on the line so as to send and receive service data to and from the second terminal;

a processor for testing data received via said ports; and

the device arranged such that service data received via one of said ports will be output substantially unchanged via the other of said ports.

A device according to the second aspect of the invention is therefore able to perform throughput testing, to monitor the performance of a circuit and of the data passing through it. This allows the device to test that the operation and data rates are as expected. The processor may be further arranged to introduce errors into the service data before it is output from the device. This allows the device to check that the error-reporting procedures in the service are functioning correctly.

According to a third aspect of the present invention, there is provided a device for testing a data carrying service operating over a telecommunications line, the apparatus comprising:

an input port for for connection to the line so as to receive service data;

a attenuation emulator for modifying the received data in a manner to emulate an length of line; and

a processor for testing the modified data.

A device according to the third aspect of the present invention is therefore able to simulate an extended length of line so as to test that the service is operating correctly over a full range. Advantageously, such in-built attenuation circuitry provides for ease and convenience of use.

It will be understood that the first, second and third aspects of the invention can be combined together in any combination into a single device.

Specific embodiments according to the invention will now be described by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a test device according to an embodiment of the present invention;

Figure 2 shows the architecture of the device in Fig. 1;

Figure 3 is a flow chart showing a summary of the test process performed using the device of Fig. 1;

Figure 4 is a flow chart showing in more detail a portion (the automatic service identification and test procedure) of the process shown in Fig 3;

Figure 5 is a flow chart showing in more detail a portion (the complex fault identification procedure) of the process shown in Fig 3;

Figures 6a and 6b are flow charts showing the processes performed during the operation of the device of Fig. 1 to store test data;

Figure 7 is a flow chart showing the process of upgrading the firmware of the device of Fig. 1;

Figure 8 is a flow chart showing the operation of the device when interacting with a secondary device to obtain additional information requested by a user; and

Figure 9 shows a test device according to a second embodiment of the invention.

Figure 1 shows a test device 1 according to a first embodiment of the present invention. Test device 1 comprises a weatherproof housing 2, a plurality of user-operable keys 3 on an in-built key pad 9 in the housing, and a liquid crystal display 4. Two RJ45 connection sockets 5 and 6 are also provided, together with a standard 9-pin female connection socket 7, and a charge point socket 8. Internally, the device comprises a power supply, and an internal circuitry architecture which is described with reference to Figure 2. The device is designed to be small and light enough such that it is easily carried by a user with one hand.

The operation of the device 1 will now be described with reference to the subsequent Figures. The internal architecture is illustrated in Figure 2. Data communication between the device 1 and the telecommunications line occurs via signal input interface 260. The operator must first physically connect the device to the telecommunications line via line connection 270. Line cable 271 is used for this, one end of which is connected into the device 1 via the RJ45 socket 5. The use of a single standardised socket connection, such as RJ45, is advantageous in that it allows the device to be connected to many different services world-wide. All that is required is the use of various adapter cables to complete the line connection 270 according to the local requirements.

Test device 1 is controlled by a central processing unit (CPU) 200. This is provided, in the embodiment, by a dedicated central processing unit designed with low power requirements for mobile computing, such as the INTEL Centrino. In addition, it includes built in wireless local access network capabilites (WiFi LAN).

Under control of the CPU, test device 1 has the abiltiy to identify and test a plurality of different data carrying services which might be present on the telecommunications line. To perform this, a plurality of test circuits 220, 230, 240, 250 are provided. ADSL test circuit 220 comprises two modem chip sets 221 and 222, independently controllable and able to emulate both ATU-C and ATU-R. ShDSL test circuit 230 comprises two modem chip sets 231 and 232 for emulating STU-C and STU-R. Also provided is PSTN test circuit 240 comprising two PSTN modems 241 and 242, such as two dial-up V.92 modems, and an ISDN test circuit 250.

When the test device 1 is connected to a metallic pair, and switched on, it steps through a sequence of tests using the relevant test circuits, so as to identify the type of service present. Information is presented to the operator (user) via an appropriate output 206, which in the embodiment is a backlit liquid crystal display 4 (such as the type which might be found in a mobile telephone) connected to the CPU. The presentation of information to the operator at appropriate stages allows the results of various tests to be displayed, and requests for further instructions / confirmation to be presented. The device is arranged to advise the user of any connection steps that are required, and will advise the user of any mistakes. The operator is able to interact with the device 1 via input 204, which in the embodiment is a built in keypad 9 connected to the CPU. Thus the operator is able to send instructions to the device, and view test results / error messages, etc. In the event that the device is unable to identify a service / fault then a highly-skilled operator may specify individual tests which may be run in order to pin-point the problem.

The arrangement of the device allows it to mimic the correct modem termination for each of a plurality of services (for example, it may emulate an ATU-C and ATU-R or STU-C and STU-R when required). It is able to check for the presence of a large number of data carrying services, including ISDN (bri on either the U or S bus), ADSL, ShDSL and POTS dialup via the same connection socket, without the need to disconnect / reconnect the device.

An expansion port 261 is also provided, connected to the signal input interface 260. This allows the addition of future modems or other connectivitly whilst still using the same connection port to connect to the line.

The power supply 201 in the embodiment is provided by a rechargeable battery pack 202, comprising for example, standard Nickel metal hydride batteries capable of powering the unit for a minimum of 120 minutes. The device is arranged to warn the user of an impending power failure at 30, 15, 5 and 1 minutes, and if the power fails, then the unit will fail gracefully without using data. Recharging is performed via charging circuit 203 connected to charge point socket 8 on the exterior of the device. Alternatively, the device may be powered for longer periods using mains electricity or external battery supply.

Communication with the device, as already discussed, is possible directly by the operator using the keypad 9. In addition, the test device 1 is provided with further communication capabilities 280, including via Bluetooth 281, serial 282 or ethernet connection 283. For example, the Bluetooth capabilities allow for wireless upload / download of information, and interaction with other Bluetooth enabled devices as part of the test procedures. Furthermore, the communication capabilites of the device allow for control of the device via an external host, and the combining of additional line test information from RS232 / Bluetooth devices to assist in complex fault identification (see Figure 5). In addition, the device allows for the addition of future services by the upgrade of firmware (see Figure 7).

The typical operation of the device shown in summary in Figure 3. The operator (user) is provided (step 1.1) with a test device 1, plus cabling for connecting to the test line. One end of the cabling is provided with a standard connector (eg RJ45) for plugging into the test device, the other end being whatever connector is appropriate for the situation. The test device is connected (step 1.2) to the line, and switched on (step 1.3) and the "Start Test" key pressed by the operator. The device then automatically steps through a sequence of predefined tests (step 1.4) which will allow it to identify the type of service present, and data is recorded (step 1.5) by the device on an internal memory provided in the processing unit 200. The device then processes the data (step 1.6) following a pre-programmed rule set in order to diagnose the results. The results are displayed to the operator (step 1.7) via the LCD display 4.

Figure 4 is a flowchart showing the procedure performed during step 1.4, for automatically identifying and testing the service type. The device is preprogrammed with the sequence of steps to run through to identify and then to test the operation of a number of services. The first service checked for is ISDN (bri). Initially, the device checks (step 2.1) whether ISDN synchronises, and if so then the ISDN test process is performed (step 2.2) to confirm it is operating correctly.

Alternatively, if ISDN 2 (BRI) is not detected then the PSTN service is checked for. For this, the device checks (step 2.3) whether there is a PSTN dial tone. If so, and the PSTN number can be recovered (step 2.4) then this is displayed to the operator (step 2.5). However, if the PSTN service is available but the PSTN number is not recovered then the device checks (step 2.6) whether ADSL synchronises. If yes, the system runs through the ADSL test process (step 2.7). If the ADSL does not synchronise at step 2.6 then the device runs through the PSTN dial up modem test process (step 2.8).

However, if at step 2.3, PSTN service is not available, then the device checks for the presence of ShDSL (step 2.9). If this is available, the device performs the ShDSL test process (step 2.10).

The reason for this sequence of tests is due to the higher voltage levels with the ISDN2 (bri) service. The sequence enables the other test circuits 220, 230, 240 to be isolated during the test so as to avoid unintentional damage. In addition, ISDN2 (bri) is the quickest service to be identified, due to the speed of its synchronisation with the central office equipment. ShDSL service is the last to be tested for as it does not rely on the conventional dial tone being present. Instead, with DC wetting (a direct current applied to the line, eg to signify the metallic pair is in use or to keep induced noise down) it is the only service which could be available.

A further aspect of the device is that it is able to perform throughput testing, ie it is able to act as a passive link within the data carrying service, allowing the data to flow normally and unimpeded (at true upstream /downstream data rates, either as a function of an ATM cell count or bytes per second), whilst continuously monitoring the service to check it is functioning correctly. To operate in this mode, the device may be connected, for example, via sockets 5 and 6 between the customer premises equipment at one end and the central office equipment at the other.

The ability of the test device to perform througput testing is due to the dual-modem arrangement in the test circuits. More specifically, the two modem chip sets 221 and 222 have links between them to allow the connections which will permit throughput testing. Similarly, in the ShDSL test circuit, the two modem chip sets 231 and 232 are provided with links between them to enable throughput testing. In addition, the device is able to inject errored cells into the data so as to test whether the error reporting in the service is functioning correctly.

Whilst dual-modem test circuits are already known in the prior art, they are not used for throughput testing. For example, known test devices include Veratas 992 ECR, available from Aware, Inc., Massachusetts (http://www.aware.com), a development system for DSL to assist developers to build and test ADSL based products and services. This DSL network test system is a dual modem test box in which each modem can emulate either an ADSL transceiver unit central office (ATU-C) or an ADSL transceiver unit remote terminal (ATU-R). In this manner, the system is able to mimic either central office or customer premises equipment, but the modems are not connected to test for throughput.

A further aspect of the device is that it has the capability to emulate different lengths of cable. This functionality is provided by in-built attenuation circuitry (including for example an appropriate resistor array) provided as part of the Signal Input Interface 260. This operates as an attentuation emulator, which can emulate a length of copper cable so as to mimics the losses (in dB, decibels) that can occur over the emulated length. To enable a fair evaluation of the circuit under test, this should be able to emulate for example a selection of 0.5mm copper cable lengths in the range of 1 kilometre to 7 kilometres. When working in PSTN and ISDN mode the attenuation emulator should allow the circuit under test to still work as normal (i.e. it restricts the frequency response of the line but not the line voltage).

The attenuation emulator incorporated into the device allows the operator to test, for example, that the DSLAM is capable of communication over a standard line length instead of the actual line length that is present. This ensures rigorous testing of the circuit under different conditions to ensure correct operation of the service. With regard to the customer end, it is useful to prove the reliability of the line pairs, i.e. that they are able to maintain a correct level of service. In this way, it is possible to limit the early failure of a copper pair on provision or restoration of service.

One further aspect of the device is that one of the RJ45 connection sockets 6 is provided with a non-standard offset tag. This identifies the one socket 6 from the other RJ45 socket 5 for the purposes of the operator, and is to ensure they plug into the correct connection socket when using the device.

Figure 5 indicates in more detail the complex fault identification procedure which may be carried out by the test device 1. The device checks whether an additional OSI (open systems interconnection) layer tester can be identified via Bluetooth (step 3.2). If no additional tester is identified then the device indicates to the operator that they should turn on the additional tester, for example by (step 3.4) displaying the message "please turn on additional tester" in the LCD display 4. The device then waits (step 3.6) for the additional tester to respond.

When the test device identifies an additional tester, the operator may be directed to the additional tester (step 3.3) for additional instructions. Details of the relevant test data are sent (3.5) to the additional tester. The additional tester performs further diagnostic test processes on the data (step 3.7), and the results are returned (step 3.8) to the test device. This re-runs the revised data set through its pre-programmed rule set (step 3.9) to identify the fault (step 3.10). If successful, the results are indicated to the operator (step 3.11) by a message on the LCD display 4. Alternatively, if still unsuccessful, test device 1 determines whether any other further tests might be run (step 3.12) and displays the appropriate messages to the operator (step 3.13).

After completion of the testing procedure, the results of output 2 the operator via the display. The operator is then asked to confirm whether the type of service is that which they expected. For example, if the test device was unable to identify (since step 2.6) ADSL service, but did verify dial tone (step 2.8) then the operator is asked to confirm that the expected service was POTS dial up only. However, if the operator here indicates that the service should actually have been ADSL, then the processing unit will perform further testing according to its predefined rule set in order to a certain weather DSL Connectivity could be established on the transport layer.

Figures 6a and 6b are flow charts showing how the test device manages its data storage during testing. Upon a request to run a specific diagnostic test (step 4.1), the device checks whether (step 4.2) there is sufficient internal memory to store the test data.

If yes, then the test can be performed (step 4.3) and the relevant data stored internally (step 4.5) however, the test device also has an option to download data to an external device if step 4.2 determines that there is insufficient memory to store the test data. In this case, the test device will search (step 4.4) for either a Bluetooth or serial connection to a host (external device). If (at step 4.6) the external device cannot be detected, then the vesting procedure must terminate due to insufficient memory (step 4.7). However, in the event that the test device is able to successfully communicate with the host (step 4.8) then the test of a memory may be downloaded to the host and then cleared (step 4.9).

After the test device had performed the tests and stored the data to an internal memory (step 4.5) then the device will enquiry (step 4.10) whether the testing is complete. Upon receiving the appropriate input from the operator via the key pad (step 4.11), the device will determine whether testing is indeed complete (step 4.13) or else whether the operator wishes to download all the test device results for central storage. If so, the device checks (step 4.14) for a Bluetooth or serial connection to a host. If this is unsuccessful, the device informs the operator (step 4.16) to turn on the host because the testing has not been stored successfully. However, if (at step 4.15) a host is successfully detected and the firmware version verified (step 4.17) then the test of the memory is downloaded (step 4.18) to the host and then cleared (step 4.19). An indication of this successful procedure (step 4.20) is provided to the operator.

Where required, the tester can be left attached to the line for up to 72 hours, to monitor the connection, and the results will be stored in the device for later analysis.

A second embodiment of a test device 100 according to the invention is shown in Figure 10. The architecture is very similar in layout to that of the first embodiment illustrated in Figure 2. However, the PSTN, ADSL and ShDSL modems, and ISDN modem have instead been replaced by the use of a field programmable gate arrays (FPGA) and digital signal processors (DSP). The use of such chip sets means that only two FPGA/DSP 101 and 102 are required. This is because the firmware needed to make them either a PSTN, a DSL, ShDSL or ISDL modem would instead be held in the memory (ROM) of the device and loaded into the chips as and when required as each circuit test takes place.

Figure 1

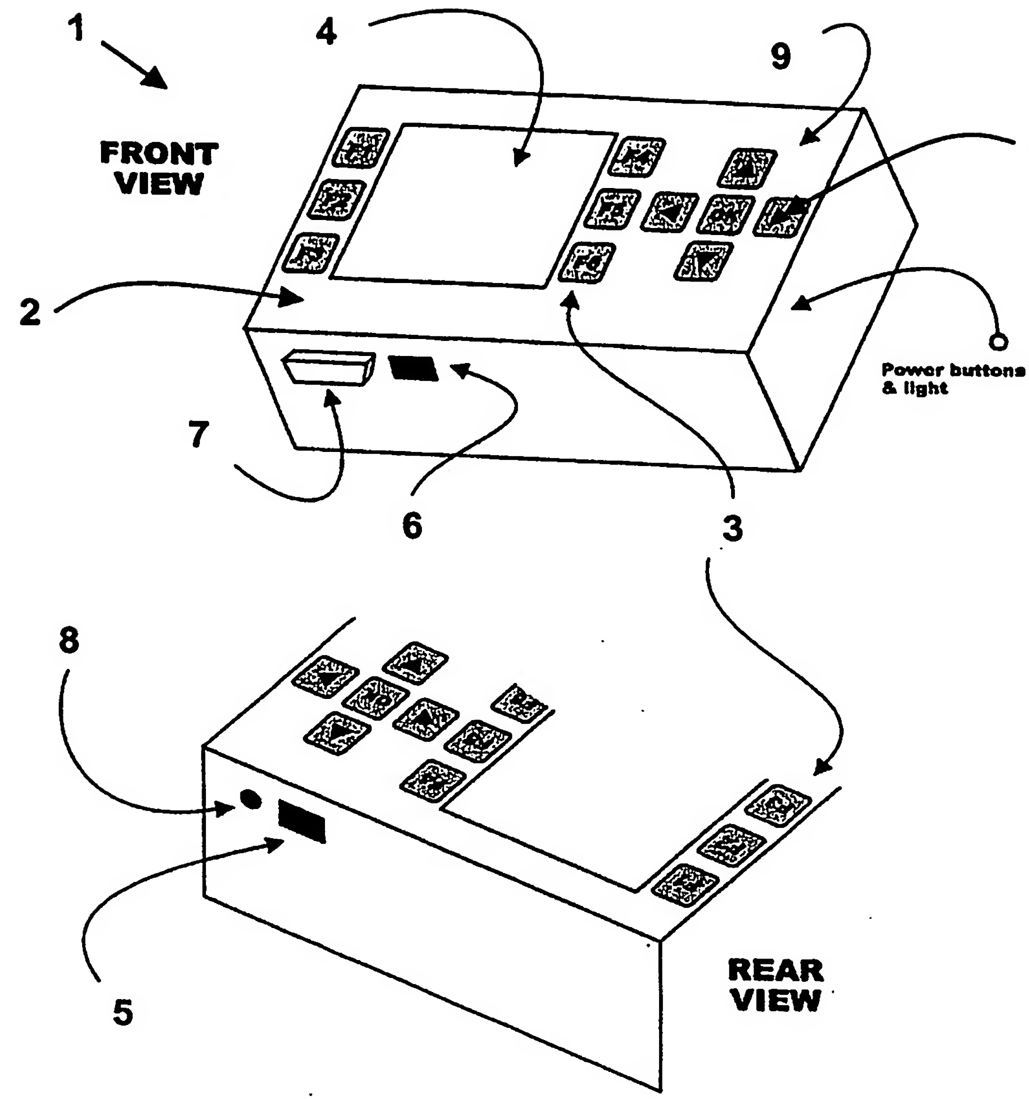


Figure 2

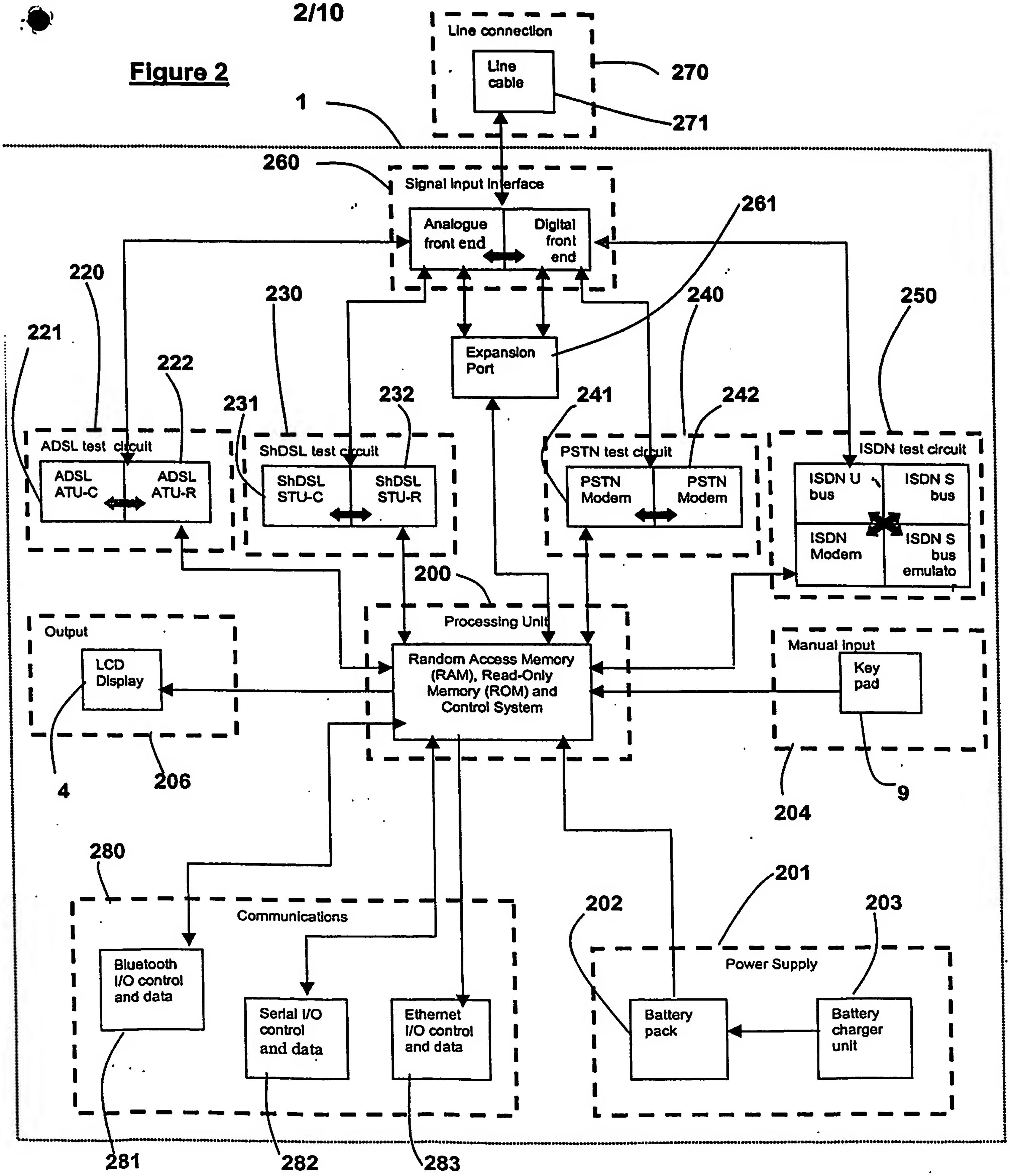

Line connection
Line cable
270
271
1
260
Signal input interface
Analogue front end
Digital front end
261
220
221
222
230
231
232
240
241
242
250
Expansion Port
ADSL test circuit
ADSL ATU-C
ADSL ATU-R
ShDSL test circuit
ShDSL STU-C
ShDSL STU-R
PSTN test circuit
PSTN Modem
PSTN Modem
ISDN test circuit
ISDN U bus
ISDN S bus
ISDN Modem
ISDN S bus emulato
200
Processing Unit
Random Access Memory (RAM), Read-Only Memory (ROM) and Control System
Output
LCD Display
4
206
Manual input
Key pad
9
204
280
Communications
Bluetooth I/O control and data
Serial I/O control and data
Ethernet I/O control and data
281
282
283
201
202
203
Power Supply
Battery pack
Battery charger unit

Figure 3

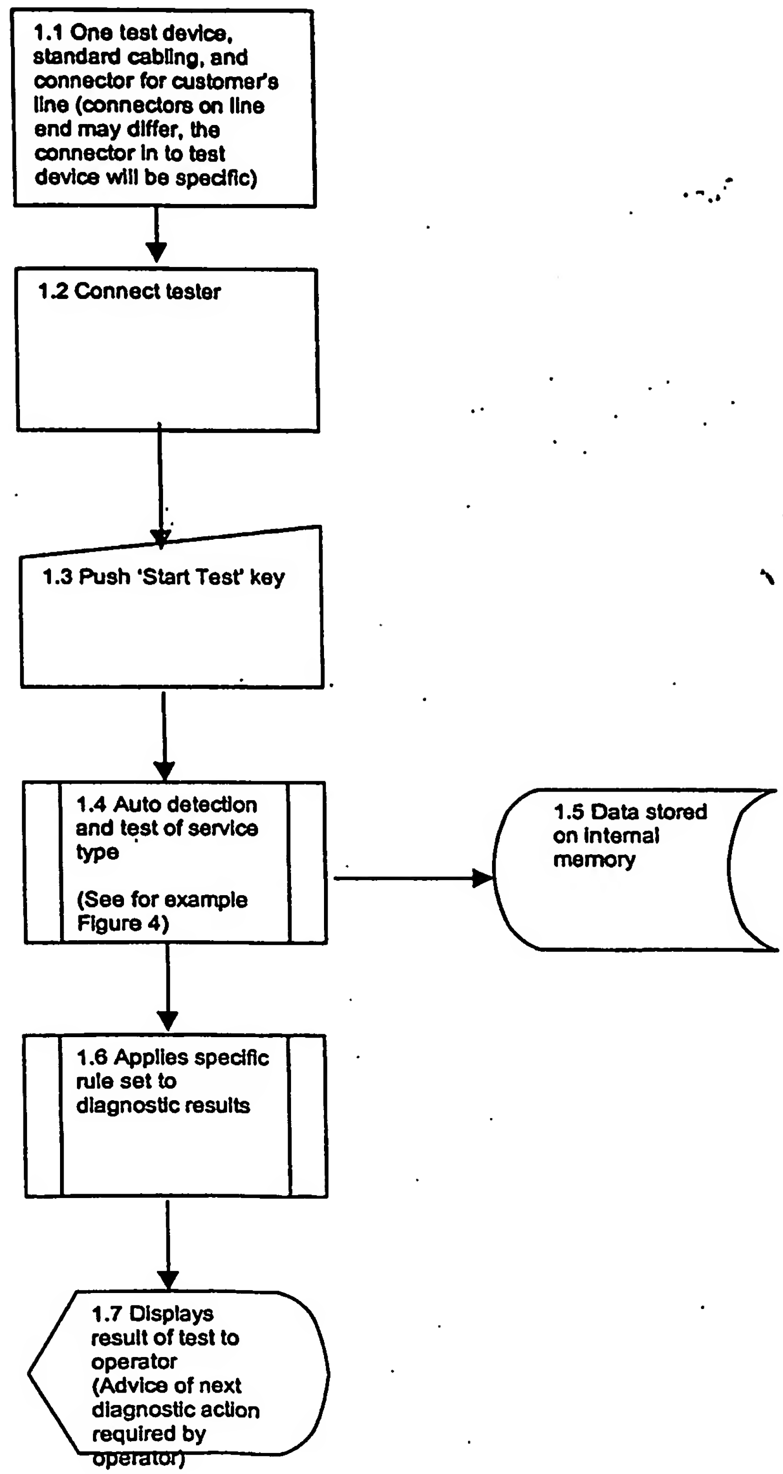
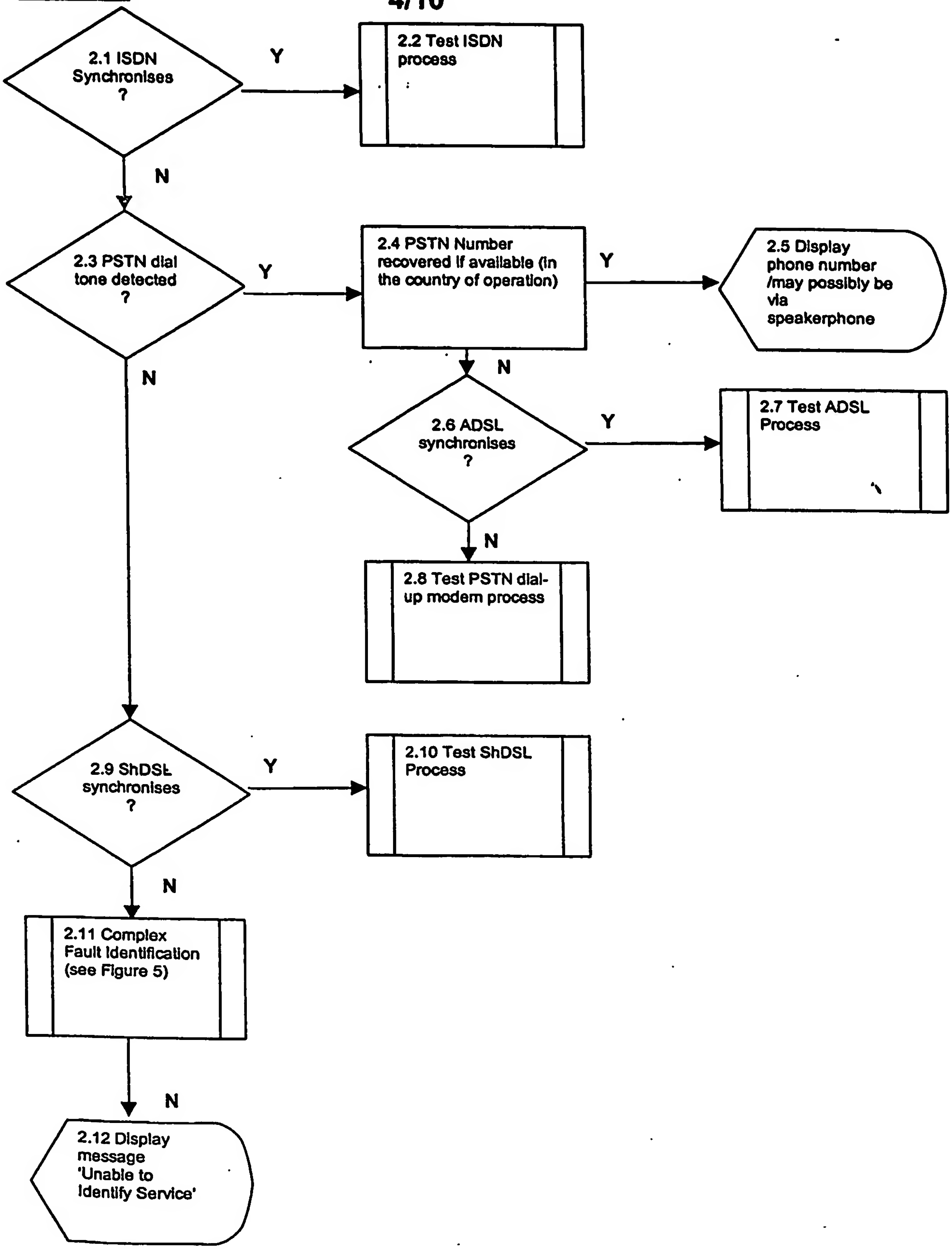

1.1 One test device, standard cabling, and connector for customer's line (connectors on line end may differ, the connector in to test device will be specific)
1.2 Connect tester
1.3 Push 'Start Test' key
1.4 Auto detection and test of service type
(See for example Figure 4)
1.5 Data stored on internal memory
1.6 Applies specific rule set to diagnostic results
1.7 Displays result of test to operator (Advice of next diagnostic action required by operator)

Figure 4



2.1 ISDN Synchronises ?
Y
2.2 Test ISDN process
N
2.3 PSTN dial tone detected ?
Y
2.4 PSTN Number recovered if available (in the country of operation)
Y
2.5 Display phone number /may possibly be via speakerphone
N
N
2.6 ADSL synchronises ?
Y
2.7 Test ADSL Process
N
2.8 Test PSTN dial-up modem process
2.9 ShDSL synchronises ?
Y
2.10 Test ShDSL Process
N
2.11 Complex Fault Identification (see Figure 5)
N
2.12 Display message 'Unable to Identify Service'

Figure 5

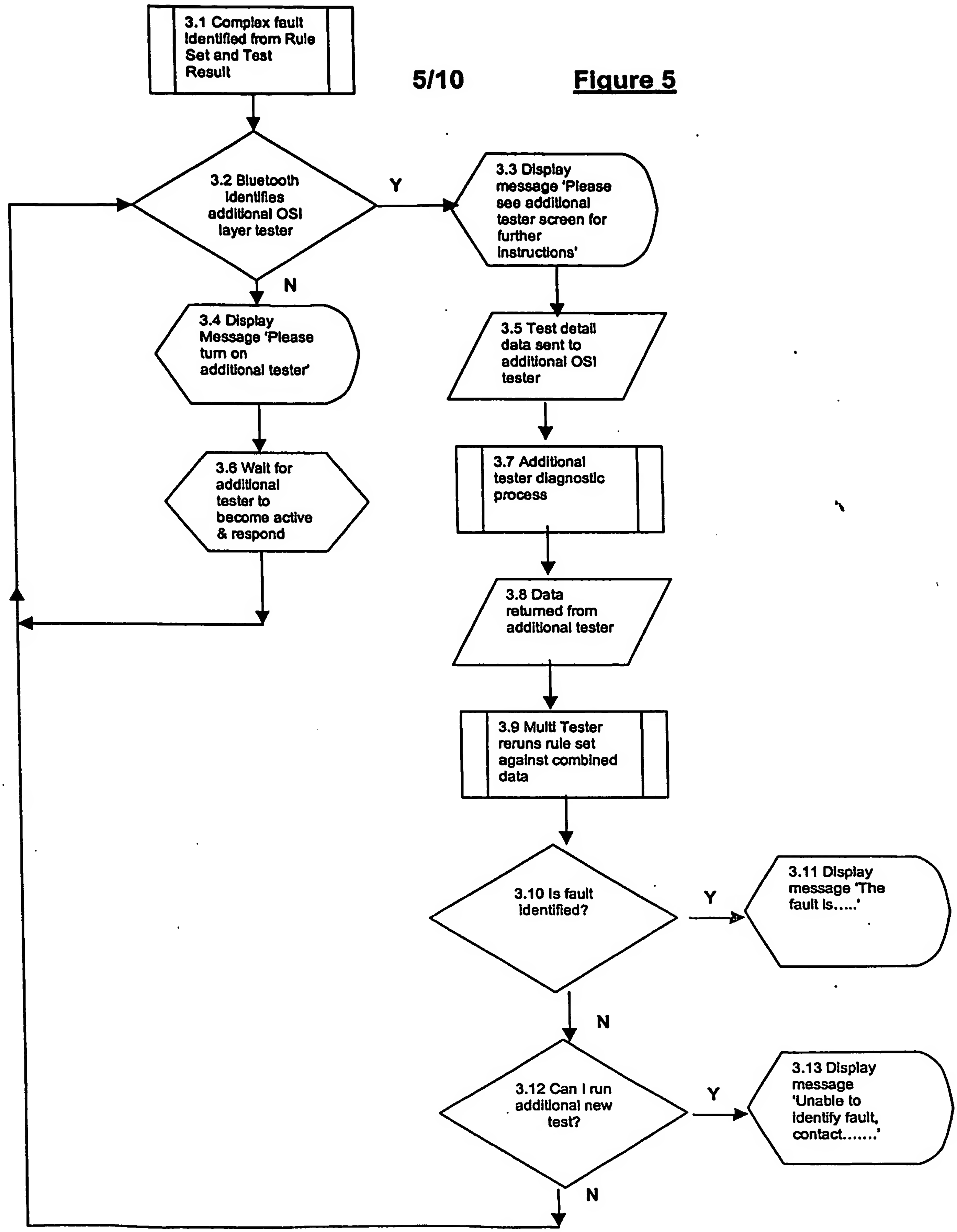
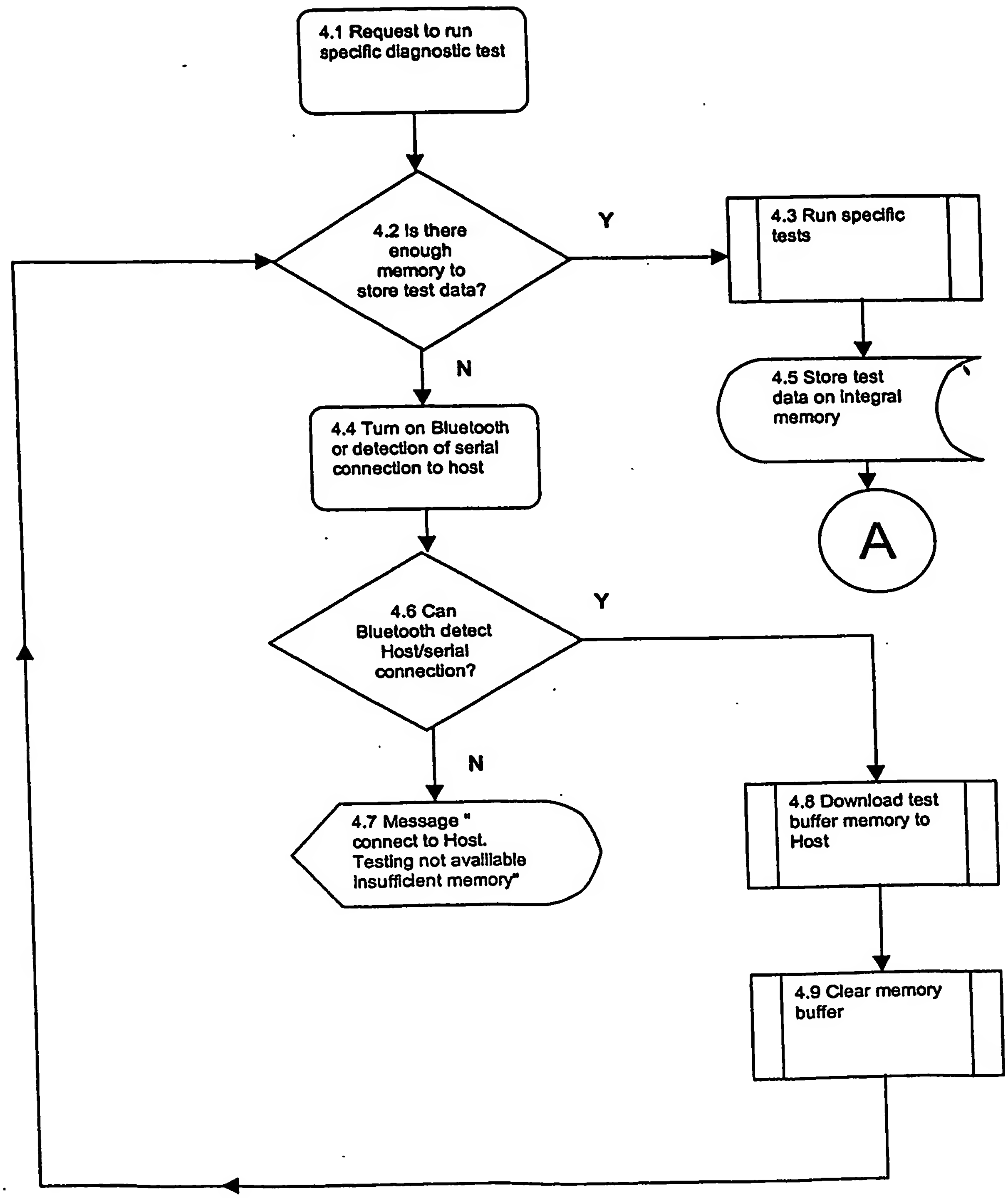

3.1 Complex fault identified from Rule Set and Test Result
3.2 Bluetooth identifies additional OSI layer tester
Y
3.3 Display message 'Please see additional tester screen for further instructions'
N
3.4 Display Message 'Please turn on additional tester'
3.5 Test detail data sent to additional OSI tester
3.6 Wait for additional tester to become active & respond
3.7 Additional tester diagnostic process
3.8 Data returned from additional tester
3.9 Multi Tester reruns rule set against combined data
3.10 Is fault identified?
Y
3.11 Display message 'The fault is.....'
N
3.12 Can I run additional new test?
Y
3.13 Display message 'Unable to identify fault, contact.......'
N

Figure 6a



4.1 Request to run specific diagnostic test
4.2 Is there enough memory to store test data?
Y
4.3 Run specific tests
N
4.4 Turn on Bluetooth or detection of serial connection to host
4.5 Store test data on integral memory
A
4.6 Can Bluetooth detect Host/serial connection?
Y
N
4.7 Message " connect to Host. Testing not availlable insufficient memory"
4.8 Download test buffer memory to Host
4.9 Clear memory buffer

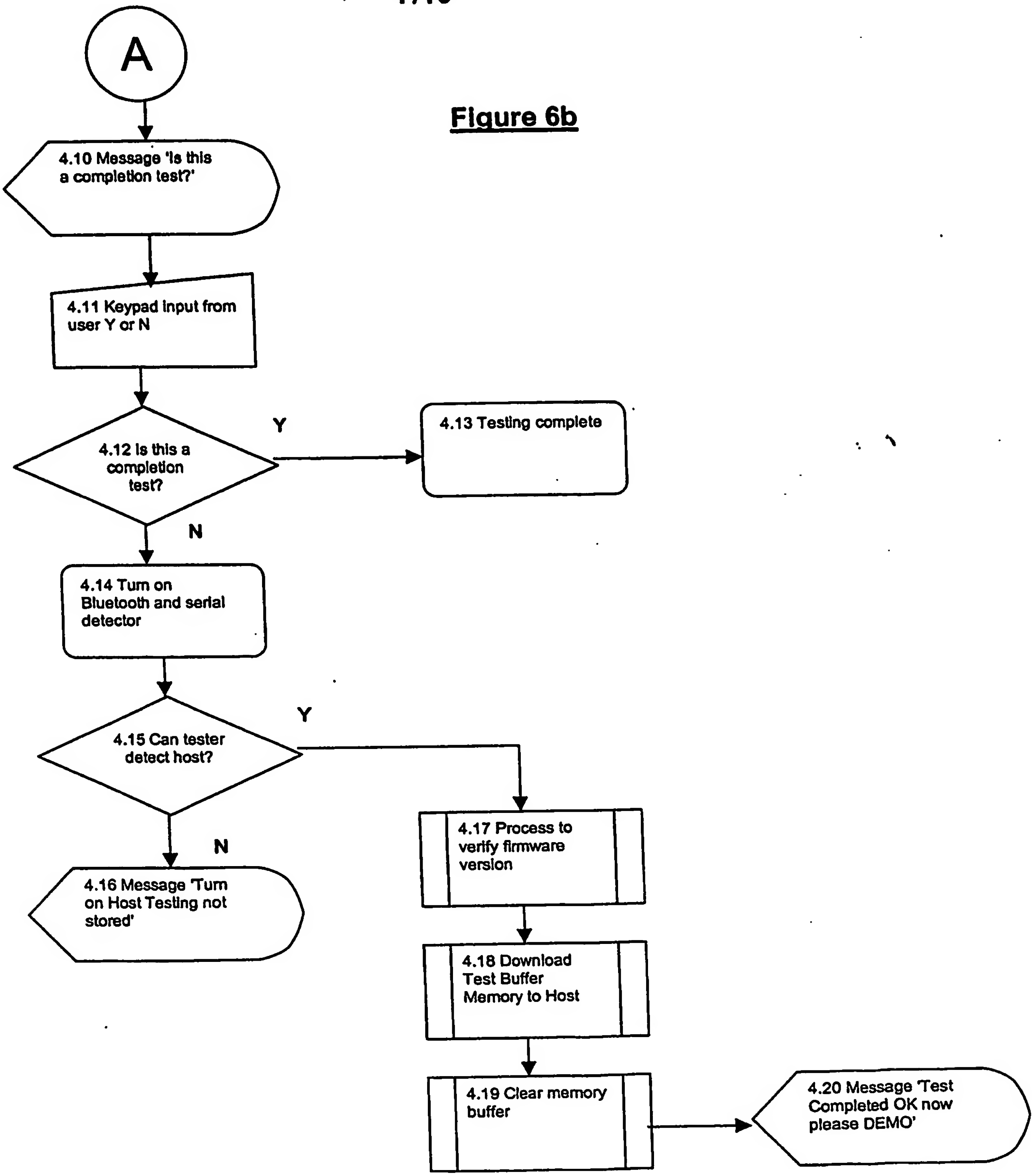

A
4.10 Message 'Is this a completion test?'
4.11 Keypad input from user Y or N
4.12 Is this a completion test?
Y
4.13 Testing complete
N
4.14 Turn on Bluetooth and serial detector
4.15 Can tester detect host?
Y
N
4.16 Message 'Turn on Host Testing not stored'
4.17 Process to verify firmware version
4.18 Download Test Buffer Memory to Host
4.19 Clear memory buffer
4.20 Message 'Test Completed OK now please DEMO'

Figure 6b

Figure 7

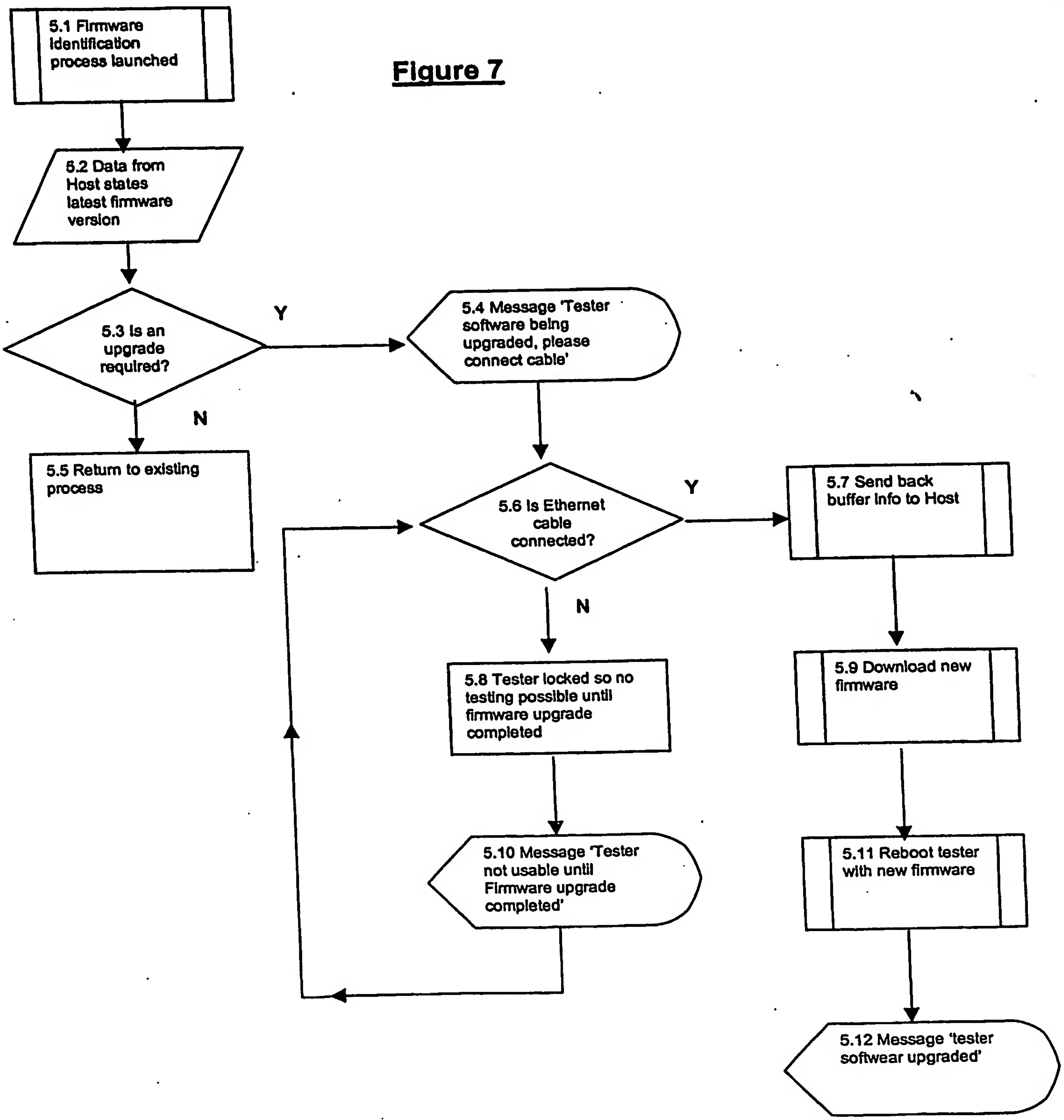

5.1 Firmware identification process launched
5.2 Data from Host states latest firmware version
5.3 Is an upgrade required?
Y
N
5.4 Message 'Tester software being upgraded, please connect cable'
5.5 Return to existing process
5.6 Is Ethernet cable connected?
Y
N
5.7 Send back buffer info to Host
5.8 Tester locked so no testing possible until firmware upgrade completed
5.9 Download new firmware
5.10 Message 'Tester not usable until Firmware upgrade completed'
5.11 Reboot tester with new firmware
5.12 Message 'tester softwear upgraded'

Figure 8

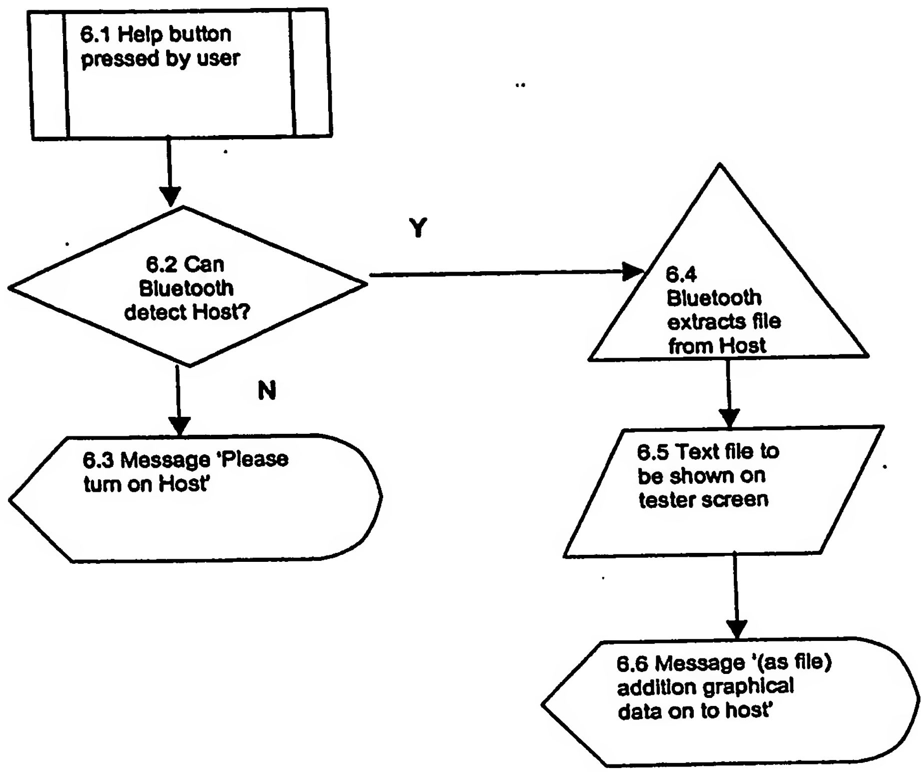
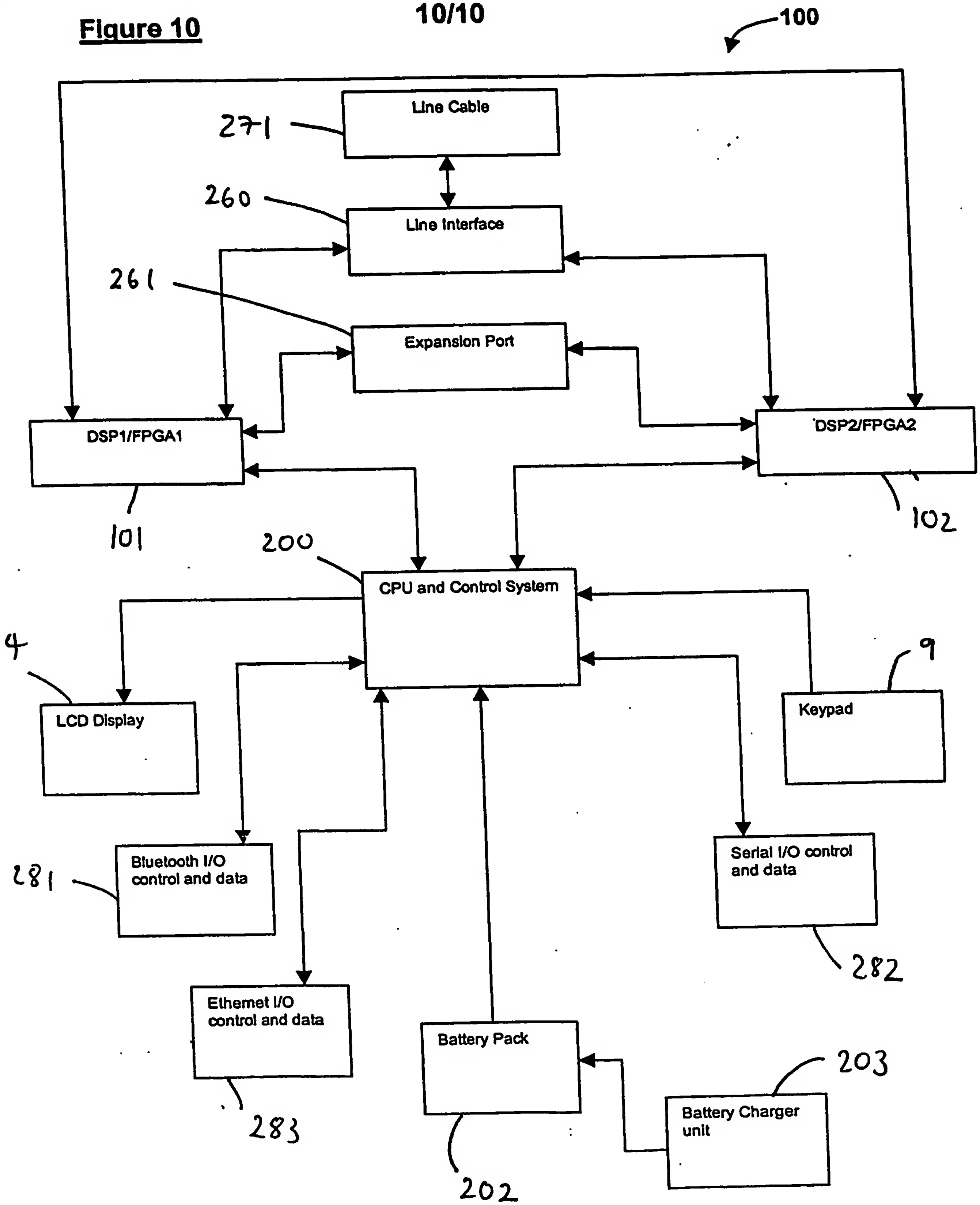

6.1 Help button pressed by user
6.2 Can Bluetooth detect Host?
Y
N
6.3 Message 'Please turn on Host'
6.4 Bluetooth extracts file from Host
6.5 Text file to be shown on tester screen
6.6 Message '(as file) addition graphical data on to host'

Figure 10


100
Line Cable
271
260
Line Interface
261
Expansion Port
DSP1/FPGA1
DSP2/FPGA2
101
102
200
CPU and Control System
4
LCD Display
9
Keypad
Bluetooth I/O control and data
281
Serial I/O control and data
282
Ethernet I/O control and data
283
Battery Pack
202
Battery Charger unit
203

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